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# Studies on the flora of northern South America—XIII. The Tate collection from Mount Roraima and vicinity[1]

H. A. Gleason

Since its first partial exploration by Schomburgk nearly a century ago, Mount Roraima and the region about it has been known for its remarkably rich flora and high development of endemism. Although the mountain stands a comparatively short distance from the coast of British Guiana on the north and from the navigable waters of the Rio Branco on the south, access to the locality has always been a matter of considerable difficulty, and botanical exploration is still by no means complete.

After the Quelch and McConnell expeditions to the mountain in 1894 and 1898, Brown discussed the botanical history, geology, flora, and phytogeography of the region and reference to his paper is recommended for information on all of these subjects.[2] Since that time apparently only two botanical collections have been made from the summit. E. Ule spent seven weeks on the slopes of the mountain in December, 1909, and January, 1910, and made four ascents to its summit. His collections included a considerable number of undescribed species.

G. H. H. Tate, of the American Museum of Natural History, conducted a zoological expedition to Mount Roraima in the winter of 1927 and 1928, and the collections of botanical material which he made incidentally form the subject of this paper. These collections as received by the New York Botanical Garden include 515 numbers, of which the first 149 were made on the savannas and accompanying marshes of extreme northern Brazil, 127 on the lower slopes of Roraima below 5000 feet altitude, 153 on the upper slopes and ledges of the mountain, and 86 on the summit plateau. Notwithstanding the difficulty in preparing material, caused by the tedious transportation of supplies and the humid climate, the whole series is ample in

[1] Contributions from The New York Botanical Garden, No. 313.

[2] Brown N. E. Report on two botanical collections made by Messrs. F. V. McConnell and J. J. Quelch at Mount Roraima in British Guiana. Trans. Linn. Soc. Bot. II. **6**: 1–107. *pl. 1–14.* 1901.

[The Bulletin for October (**56**: 339–390) was issued 7 November 1929.]

quantity, excellent in quality, and generally in good condition for study, and it forms a notable addition to the meager representation of this flora in American herbaria.

In identifying the collection, I have had the advantage of comparison with the older Roraima material in the herbarium of the Royal Botanic Gardens at Kew. Here are found the original sets of Schomburgk, Appun, Im Thurn, and Quelch and McConnell, including the types of the numerous species discovered by them, and an almost complete set of the later collections of Ule. I have also had for certain groups the assistance of several American specialists, including Oakes Ames (Orchidaceae), J. H. Barnhart (Lentibulariaceae), S. F. Blake (Carduaceae, Polygalaceae), N. L. Britton (Cyperaceae, Mimosaceae), Carl Epling (Labiatae), A. S. Hitchcock (Gramineae), E. P. Killip (Boraginaceae, *Passiflora*, *Weinmannia*, *Viburnum*), W. R. Maxon (Pteridophyta), F. W. Pennell (Scrophulariaceae), B. L. Robinson (Eupatorieae), P. A. Rydberg (Carduaceae), A. C. Smith (Pteridophyta, *Weinmannia*, *Viburnum*), L. B. Smith (Bromeliaceae), P. C. Standley (*Ficus*, Rubiaceae), and Percy Wilson (*Phytolacca*, *Jussiaea*).

Lack of space prevents the printing of a complete list of the collection, which includes more than four hundred species, and I give below merely diagnoses of several hitherto undescribed species, a few nomenclatorial changes, and occasional informatory notes. These have in several cases been prepared by one or another of the botanists named above. The article concludes with a list of additions to the known flora of the higher altitudes of Mount Roraima.

## 1. NEW OR NOTEWORTHY SPECIES

DICHROMENA sp. A species apparently without a name; it was distributed in the Spruce collections as *Psilocarya monostachya*. On mud where water is receding, Limao, extreme northern Brazil: *no. 73.*

**Xyris decussata** Gleason, n. sp. Section NEMATOPUS: caulescent, the strongly distichous leaves inserted about 6 mm. apart; sheaths strongly compressed, sharply carinate, dark chestnut-brown, 6–8 mm. wide at base, 4–6 cm. long, the margins entire, the carina ciliate above, entire below: blades linear, 3–5 mm. wide, 5–8 cm. long beyond the sheath, obtuse or rounded, silvery-green, finely many-nerved, densely ciliate

with dark brown hairs; scapes strongly flattened and 2-edged, somewhat twisted, 25–45 cm. tall, sheathed at base with a nearly bladeless leaf, entire below, densely ciliate above; heads subglobose, 9–12 mm. long; bracts all obtuse or rounded, not carinate, reddish-brown, the dorsal area none or indistinct, the lowest 2 mm. long and ovate-lanceolate, the inner progressively larger and as much as 6 mm. long and 4 mm. wide, the outermost 6–8 pairs sterile and decussate, forming 4 vertical rows of 3–4 bracts each, the upper bracts spiral and fertile; lateral sepals 7 mm. long, narrowly oblong, acute, nearly equilateral, the margins subhyaline, the keel minutely fimbriate on the distal half; corolla and stamens not seen; capsule obovoid, loculicidal, 5 mm. long.

Type, *Tate 427*, collected on the summit of Mount Roraima,[3] British Guiana, 26 Nov. 1927, and deposited in the herbarium of the New York Botanical Garden. In its strongly caulescent habit it is reminiscent of *X. witsenioides* Oliver, from which it differs in its ciliate leaves and scapes and decussate bracts. Its affinities seem to be rather with *X. spectabilis* Mart. and its relatives, constituting a small group on the campos of southern Brazil. These also have ciliate leaves and sterile lower bracts, but are regularly much larger in all dimensions and have spirally imbricate bracts throughout.

**Xyris submontana** Gleason, n. sp. Section NEMATOPUS: cespitose; leaves distichous, the sheaths sharply carinate, 1–2 cm. long, the blades narrowly linear, 7–13 cm. long, 2–3 mm. wide, acuminate to a subulate tip, glabrous; scapes 4–6 dm. tall, very slender, slightly flattened, the basal sheath about 10 cm. long, nearly bladeless; heads subglobose, 8–10 mm. high; outer bracts broadly ovate, 4 mm. long, the distal margin scarious and lacerate; principal bracts with a firm, brown, broadly cuneate-obovate body 5–6 mm. long, terminated distally by a scarious lacerate margin 2–3 mm. long, the dorsal area not differentiated; lateral sepals obtuse, broadly spatulate or narrowly obovate, 3.5–4 mm. long, 1.2 mm. wide, the thin membranous margins nearly equilateral, the keel finely but conspicuously and rather densely ciliate over nearly its whole length.

Type, *Tate 334*, collected in Philipp Swamp, Mount Roraima, British Guiana, alt. 5100–5200 ft., 11 Nov. 1927, and deposited

[3] The small area on the summit of Mount Roraima is shared by Brazil, Venezuela, and British Guiana, and the dividing line between them has not been accurately located. All species mentioned in this article from the summit and slopes of the mountain have been credited to British Guiana as a matter of convenience.

in the herbarium of the New York Botanical Garden. Its relation seems to be with *X. concinna* N. E. Brown, another Roraima species, which it resembles in its broadly scarious-margined bracts. It differs, however, in its general size, the leaves being nearly twice as long and wide and the scape three times as tall as in *X. concinna*, and in the shape of its lateral sepals, those of *X. concinna* being 5–6 mm. long and less than 1 mm. wide.

**Syngonanthus biformis** Gleason, new comb. (*Paepalanthus biformis* N. E. Brown.) This endemic species is undoubtedly a *Syngonanthus*, as already recognized by Ruhland. In this recent monograph he united it with *S. simplex* (Miq.) Ruhl., from which it is abundantly distinct. At the edge of water, Frechal, extreme northern Brazil: *no. 21*; also from above 5000 ft. on Mount Roraima: without number.

**Syngonanthus glandulosus** Gleason, n. sp. Leaves linear, spreading or recurved, about 10 mm. long, 1.5 mm. wide, 7-nerved, finely puberulent beneath, conspicuously pubescent with appressed hairs above, from a densely lanate stem; peduncles 7–11 cm. long, glandular-pubescent with hairs 0.4–0.5 mm. long, roundly 3-costate, lightly twisted; sheaths twisted, about 1 cm. long, thinly hirtellous, terminating in an ovate-lanceolate acuminate lamina 5 mm. long, the sides meeting in a rounded sinus; heads hemispheric, about 7 mm. in diameter; outer bracts imbricate, the inner progressively longer, scarious, glabrous, lanceolate to elliptic oblong, sharply acute, as much as 3 mm. long by 1.1 mm. wide; subtending bracts none; receptacle villous; staminate flowers: pedicels 0.6 mm. long; sepals rhombic-elliptic, 1.8 mm. long, 0.7 mm. wide, more or less naviculate, sharply acute or acuminate, not falcate, glabrous, the posterior a trifle shorter and narrower; petals united into an obconic tube 0.5 mm. long with 3 very short lobes; pistillate flowers: pedicels 0.2 mm. long; sepals ovate-lanceolate, 2.2 mm. long, 0.6 mm. wide, acuminate, hyaline, glabrous; petals narrowly cuneate-obovate, separate and densely pubescent below, connate about the middle, the lobes involute and tangled; pistil just equaling the corolla, the ovary 0.6 mm. long, the terete style, filiform simple stigmas, and filiform capitate appendages each 0.3 mm. long.

Type, *Tate 345*, collected at Philipp Swamp, in the Roraima district of British Guiana, alt. 5100–5200 ft., 11 Nov. 1927, and deposited in the herbarium of the New York Botanical Garden. The plant consists of a number of short erect stems which are

densely leafy and send out numerous peduncles from the upper axils. In general habit it resembles *S. simplex*, *gracilis*, and *biformis*, and differs from the first in its appendaged style, from the second in its narrow acute bracts, from the last in its symmetrical sepals, and from all three in the rounded sinuses of its peduncular sheaths.

PLEUROTHALLIS VAGINATA Schlechter. In humid forest on Mount Roraima at 6900 ft.: *no. 489*. This collection records an extension of the known range of the species from Costa Rica into South America.

Four undescribed species of orchids have been detected in the collection by Professor Ames and will be described by him elsewhere.

**Chamaecrista bauhiniaefolia** (Kunth) Gleason, new comb. (*Cassia bauhiniaefolia* Kunth) Small marsh near Limao, extreme northern Brazil: *no. 121*.

**Chamaecrista Roraimae** (Benth.) Gleason, new comb. (*Cassia Roraimae* Benth.) Along the Kukenaam river at Roraima ford: *no. 176*.

**Aeschynomene laxa** Gleason, n. sp. Suffrutescent, erect, freely branched, 5 dm. high or more; stems slender, terete, essentially glabrous, sparsely marked with minute purple spots bearing a single short central hair; stipules soon deciduous, linear-subulate, the terminal lobe 4–6 mm. long, the basal 1.5–3 mm. long; principal leaves 5–6 cm. long, erect, with 50–70 leaflets, the upper much smaller with fewer leaflets; leaflets obliquely elliptic-oblong, rounded and minutely apiculate at the summit, the midvein central, varying in size from 3 mm. at the base to 1.5 mm. long at the summit of the leaves, or only 1 mm. on the uppermost leaves; racemes axillary, about 5-flowered, elongating during anthesis to 6 cm., the rhachis spotted like the stem; pedicels 3 mm. long, becoming 5–7 mm. in fruit; prophylla oblong-elliptic, 1.3 mm. long; calyx (including the hypanthium) 3.1–3.2 mm. long, its tube 1.2–1.3 mm., deeply bilabiate, the upper lip with 2 ovate rounded lobes 0.5 mm. long, the lower with 3 oblong-ovate lobes 0.6–0.7 mm. long; vexillum round-spatulate, 4 mm. long, dotted with purple; fruiting stipe slender, 7 mm. long; joints of the legume 2, rhombic-ovate, 3.5 mm. long, 3 mm. wide, with much thickened sutures, slightly convex above, broadly rounded below, the surface somewhat veiny and glabrous.

Type, *Tate 10*, collected on the edge of a swamp at Frechal, in northern Brazil, south of Mount Roraima, 6 Sep. 1927, and

deposited in the herbarium of the New York Botanical Garden. It is most closely related to *A. filosa* Mart., from which it differs in its smaller flowers, less deeply lobed calyx, purple-dotted vexillum, and narrower stipules.

**Bowdichia parvifolia** Gleason, n. sp. Tree, height not stated; branches finely brown-pubescent or subvelutinous; petioles 2–2.5 cm. long, thinly pubescent; rhachis of the once-pinnate leaves more densely pubescent; leaflets 5–11, sessile, firm or coriaceous, narrowly oblong-lanceolate, 12–18 mm. long, 3–5 mm. wide, obtuse, slightly revolute, cuneate at base, minutely pubescent and reticulately veined above, densely pubescent, especially on the midvein, beneath; panicle ample, terminal, consisting of several racemes 5–10 cm. long, the lowest subtended by foliage leaves; peduncle 3–5 cm. long, with the rhachis minutely puberulent, bearing 5–10 flowers on pedicels 3–5 mm. long with a pair of minute bractlets near the middle; hypanthium campanulate, fleshy, 3.6 mm. long; calyx-tube gradually widened upward, subfleshy, 3.6–4 mm. long, purple distally; calyx-lobes erect, broadly triangular, 1.5 mm. long by nearly twice as wide, densely white-ciliate, sparsely pubescent externally, separated by narrow acute sinuses; standard broadly flabellate-cuneate, the claw 3 mm. long, the blade 8 mm. long, 13 mm. wide, deeply emarginate, erose and crisped; wings with a claw 5 mm. long, the blade obovate, 10 mm. long, 7 mm. wide, rounded and erose distally; keel petals separate, narrowly oblanceolate, 10 mm. long, the claw gradually widened into a blade 3 mm. wide; stamens 10, separate, filaments subulate, ultimately somewhat exceeding the sepals and 6 mm. long; anthers versatile, broadly elliptic, 0.8 mm. long; ovary on a glabrous stipe 2.7 mm. long, straight, many-seeded, 4 mm. long, thinly villous; style slender, abruptly incurved to the capitate stigma.

Type, collected by *Tate* without number, on the savanna at Frechal, south of Mt. Roraima, northern Brazil, 30 Sep. 1927, and deposited in the herbarium of the New York Botanical Garden. Of the true Bowdichias with stipitate ovary only two species have hitherto been described. The common *B. virgilioides* has leaves three times as long and five times as wide with an almost or quite glabrous ovary, and *B. nitida* Spruce has similarly large leaves and is glabrous throughout, except for the ovary.

QUALEA SCHOMBURGKIANA Warm. Our specimen agrees in all essential features with Schomburgk's original specimen and with Warming's description, but has larger flowers, the petal

being 5 cm. long and 5.5 cm. wide. A tree on the riverside at Arabupu, Mount Roraima, alt. 4200 feet: *no. 206*.

**Polygala microspora** Blake, n. sp. Tiny glabrous annual, branched above; leaves alternate, linear, 7 mm. long or less; racemes dense, acute, 4–7 mm. long, 2–3 mm. thick, scarcely comose; flowers white; wings oval, 1.5–1.7 mm. long; keel with small, slightly lobed crest; capsule oval, 1.2 mm. long; seeds pyriform, glabrous, black, 0.5 mm. long, minutely favose; aril reduced to a minute knob.

Plant slender, 3–5 cm. high, leafy, the somewhat spreading branches up to 2.5 cm. long; leaves acutely callous-pointed, fleshy, 4–7 mm. long, 0.3–0.5 mm. wide; racemes short-peduncled, conic-cylindric; bracts ovate, short-acuminate, 0.7 mm. long, glabrous, with greenish center and pale margin, deciduous (?); pedicels spreading, about 0.3 mm. long; upper sepal oval, obtuse, 0.8–1 mm. long, whitish with greenish biglandular thickening at base, obscurely erose above; lower sepals similar, oval-ovate, 0.5 mm. long; wings scarcely clawed, broadly rounded, sometimes obscurely erose above, 3-nerved, 0.9–1.2 mm. wide; keel 1.2 mm. long, the crest on each side of a broadly triangular sometimes bifid lobe; upper petals obovate-oblong, truncate-rounded, about 2-veined, 1.4 mm. long; anthers 6, longer than the glabrous free portion of the filaments; style short, thick, scarcely longer than the stigmata; upper stigma excavate, with a short nearly sessile crest; capsule rounded, emarginate, 0.9 mm. wide; seed pointed at base, rounded and minutely umbonate at apex.

Brazil: edge of marsh, Frechal, near Mt. Roraima, 6 Sept. 1927, *G. H. H. Tate 15* (type in herb. N. Y. Bot. Gard.; photog. and fragm., U. S. Nat. Herb.).

A species of the Tenues group of the subgenus ORTHOPOLYGALA, related to *P. subtilis* H. B. K. and *P. gracillima* S. Wats., but at once distinguished by its pyriform seed. From description, it was first thought that the specimens might be referable to *P. Spruceana* A.W. Bennett. Examination of the type (*Spruce 3734*) of that species, made available through the kindness of Dr. A. W. Hill, has shown that while the two species are similar in appearance, the seed of *P. Spruceana* is nearly oblong, 1 mm. long, and provided with a two-lobed aril 0.8 mm. long. —S. F. BLAKE.

**Chaetocarpus stipularis** Gleason, n. sp. Low tree; stems terete, minutely appressed pubescent with ferruginous hairs when young, glabrous in age, the internodes 2–4 cm. long;

stipules subcoriaceous, erect, inequilaterally ovate, 10 mm. long, 5 mm. wide, acute, glabrous, 2–3 nerved; petioles narrowly winged, 3 mm. long, sparsely pubescent, soon becoming glabrous; leaf-blades coriaceous, shining, ovate-lanceolate, 6–8 cm. long, 3–4.5 cm. wide, acuminate to an obtuse apex, entire, obtuse at base, glabrous, the lateral nerves 6–8 on each side, the veinlets reticulate, scarcely elevated; pistillate flowers fascicled in the upper axils, sessile or with pedicels 1–3 mm. long; pedicels and calyx minutely but densely pubescent; sepals imbricate, broadly ovate, ciliate; petals none; fruiting pedicels 5–7 mm. long, nearly smooth; capsules woody, 1 cm. long, subspherical, densely echinate, the echinae obtuse, terminated by a short, deciduous hair; valves bifid to the middle; seeds short-stipitate, ovoid, 6 mm. long, black and shining, somewhat flattened on the sides, rounded on the back, tipped with a large, 2-lobed, red caruncle.

Type, *Tate 194*, collected on the river-side at Arabupu, Mt. Roraima, alt. 4200 ft., 1 Jan. 1928, and deposited in the herbarium of the New York Botanical Garden. *C. stipularis* differs from *C. Schomburgkianus* Pax & K. Hoffm., the only species hitherto known from the region, in its shorter, more shining leaves on much shorter petioles, its much larger stipules of entirely different shape, and in some details of the fruit and seeds. There are still one or two other undescribed species in British Guiana.

CYRILLA BREVIFOLIA N. E. Brown. Summit of Mount Roraima: *no. 387a*, *401*; on savannas at Arabupu, slopes of Mount Roraima, alt. 4200 feet: *no. 287*. The species was originally collected on, and supposed to be endemic to, the summit of the mountain. Our specimen from the lower altitudes has much larger leaves, up to 35 mm. in length, with the lateral veins more evident.

WEINMANNIA LAXIRAMEA Killip & Smith. Summit of Mount Roraima: *no. 395*.

WEINMANNIA VENEZUELENSIS Killip & Smith. Summit of Mount Roraima: *no. 383*.

MELOCHIA PARVIFOLIA HBK. A form with unusually small leaves, on hardpan soil at Limao, extreme northern Brazil: *no. 97*.

**Ouratea Tatei** Gleason, n. sp. Arborescent, glabrous throughout; branches brown, the bark soon exfoliating; petiole stout, 1 cm. long, channeled above; leaf-blades coriaceous, opaque,

oblong, 13–16 cm. long, 27–57 mm. wide, broadly acute at base, entire, acuminate to a subacute apex, the lateral veins obscure, strongly curved-ascending; panicle terminal, freely branched, 20 cm. long; pedicels 3–6 mm. long, slender; buds ovoid, acute, 6 mm. long; sepals ovate-lanceolate, acute, the outer two with very narrow scarious margins, the inner two broadly scarious on each side and the intermediate one scarious on one side; petals yellow, herbaceous, broadly spatulate-rotund from a cuneate base or claw, 9 mm. long, 7.5 mm. wide; anthers nearly sessile, subulate, straight, 6 mm. long; gynophore about equaling the ovaries; carpels 5, 1 mm. long, ovoid; style stout, 6.5 mm. long, gradually tapering from the base to the punctiform stigma.

Type, *Tate 220*, collected in humid, deeply shaded ground in the Weitipu forest, Arabupu, on the slopes of Mount Roraima, British Guiana, alt. 4200 ft., 1 Jan. 1928, and deposited in the herbarium of the New York Botanical Garden. The same species is also represented in the Kew herbarium by an unnumbered collection of Im Thurn from the same locality. It is most closely related to *Ouratea rigida* Engl. from the Rupununi region south of Roraima.

**Hypericum roraimense** Gleason, n. sp. Section BRATHYS, subsection EUBRATHYS; fruticose; stems freely branched, about 2 dm. long, 4-angled above, the internodes 1–1.5 mm. long; leaves crowded and concealing the stem, firm or subcoriaceous, spreading or ascending, sessile, flat, slightly carinate toward the base, narrowly oblong-lanceolate, 7–10 mm. long by a fifth as wide, 1-nerved with two pairs of faint ascending lateral nerves, acute, entire; flowers solitary, terminal, the pedicels 1.5 mm. long and much exceeded by the upper leaves; sepals lanceolate, acute, erect, firm, two 5.7 mm., two 5.1 mm., one 4.7 mm. long by a third as wide, 3-nerved; petals persistent, yellow, obliquely obovate-oblong, 9 mm. long, 3 mm. wide, several-nerved; stamens about 25, separate to the base, the filaments 4–5 mm. long; ovary 1 celled with 2 or 3 placentae, 1.7 mm. long; styles 2 or 3, separate to the base, erect, subulate, 4.6 mm. long.

Type, *Tate 412*, collected on the summit of Mt. Roraima, alt. 8650 ft., 27 Nov. 1927, and deposited in the herbarium of the New York Botanical Garden. It is obviously closely related to the Andean species, which it resembles in habit and in general structure. Of the latter, but three species agree in the possession of flat narrow leaves and 3 styles conspicuously longer

than the ovary. *H. Jussiaei* and *H. thymifolium* have shorter petals, styles, and filaments and about twice as many stamens, while the third, *H. Phellos* Gleason, has much larger petals, longer styles, and about 100 stamens. Various species of the genus are known from the Venezuelan Andes, but *H. roraimense* is the first species reported from the Guianas.

**Tibouchina pseudomollis** Gleason, n. sp. Stem densely hirsute with pale brown, ascending, simple hairs 1–1.5 mm. long, less densely so above, the internodes 3–6 cm. long; petioles hirsute like the stem, 3–5 mm. long; leaf-blades firm, ovate-lanceolate, the largest 41 mm. long and 19 mm. wide, the upper somewhat reduced, acuminate, minutely serrulate, abruptly acute at base, 5-nerved, upper surface densely hirsute with ascending simple hairs 2–3 mm. long from an adnate base, lower surface hirsute with whitish hairs 1–3 mm. long from a simple base; inflorescence a freely branched panicle, the nodes subtended by bracteal leaves 10–15 mm. long; flowers 5–merous; hypanthium tubular-campanulate, 10-ribbed, 5 mm. long to the torus, villous with ascending simple hairs 2–2.7 mm. long from papillose bases; calyx-tube prolonged 0.4 mm., somewhat flaring, the acute sinuses subtended by straight, simple, reflexed setae nearly 3 mm. long; sepals with a broadly deltoid membranous base 2.4 mm. wide and 1.3 mm. long, tipped by a stoutly subulate apex 2.3 mm. long, ciliate throughout, the prominent midrib hirsute; petals broadly obovate, pink, 8 mm. long, 7 mm. wide, finely ciliate with glandular hairs; stamens essentially isomorphic and equal; filaments straight, subterete, glabrous, 5–6.7 mm. long; anthers stoutly subulate, 4.4 or 5 mm. long; connective prolonged 0.7 or 1.3 mm. to the apex of the filament, with a small dorsal basal protuberance and two deflexed basal ventral lobes 0.4 mm. long; ovary half inferior, 5-celled with intruding placentae, short-hirsute on the free summit and tipped with a crown of erect terminal cilia; style glabrous, straight, 10.5 mm. long, narrowed slightly below the capitate stigma.

Type, *Tate 275*, collected on sandstone boulders at Philipp Camp, Mt. Roraima, alt. 5200–6000 ft., 7 Nov. 1927, and deposited in the herbarium of the New York Botanical Garden. It is a member of the section Diotanthera, with the general habit of the Andean *T. mollis*.

**Siphanthera cordifolia** (Benth.) Gleason, new comb. (*Meisneria cordifolia* Benth., *Siphanthera microlicioides* Cogn.) Philipp Swamp, on the slopes of Mount Roraima, alt. 5100–5200 feet: *no. 341.*

An unidentified sterile specimen of a Vacciniaceous shrub was collected on the upper slopes of the mountain: *no. 284*. This is identical with *Schomburgk 566*, from about the same locality, which is also sterile.

BEJARIA (BEFARIA) IMTHURNII N. E. Brown. Summit of Mount Roraima: *no. 407*. Three small branches of this species, two in flower and one with young fruits, represent Im Thurn's original collection in the Kew herbarium. Oliver did not assign them a specific name, but did recognize that two forms were included, as shown by his published report and by his pencilled note on the sheet. Whether by accident or design, one sheet bears two twigs of one form and a second sheet a single stem of the other, which was obviously mounted there after Oliver's report was printed. Brown, in drawing up his specific description, had the additional advantage of twelve twigs collected by Quelch and McConnell. Of the total of fifteen twigs, the two collected by Im Thurn and labeled by Brown are logically the type. Brown also saw the two forms and drew up his description to include both. Since the differences between them lie in three sets of characters and are perfectly constant, the two may well be separated as distinct species. The distinctive characters of *B. Imthurnii* are: stem and pedicels densely pubescent to nearly glabrous, with slender, tapering, non-glandular hairs; leaves ciliate to entire, the cilia when present of slender simple bristles; midvein often ciliate toward the base; sepals erose-denticulate to fimbriate. In the second form, described below, the characteristic features are the callous black glands along the leaf-margin, the glandular hairs on the stem and midvein, and the entire sepals.

**Bejaria Tatei** Gleason, n. sp. A low, freely branched shrub; stem and pedicels densely pubescent with spreading, dark-brown, glandular hairs 0.6–0.9 mm. long, the glands frequently deciduous on the older parts; internodes 1–4 mm. long; leaves crowded toward the end of the branches, their blades coriaceous, light green above, greenish white beneath, elliptic or oblong, 15–25 mm. long by half as wide, or the uppermost somewhat smaller, subacute, slightly revolute, tapering at base into a margined petiole 1–3 mm. long, the margin densely (5–7 per mm.) scabrid with conic or truncate-conic black callous glands 0.2–0.3 mm. long and the apex of the blade transformed into a similar gland; midvein, especially along its basal

half, with stalked glands 0.4–0.8 mm. long; inflorescence a crowded abbreviated terminal raceme; pedicels glandular like the stem, 5–15 mm. long; hypanthium broadly campanulate to hemispheric, 1.3–1.6 mm. long, red, sometimes glandular-pubescent; petals oblong, retuse, about 2 cm. long; sepals broadly triangular-ovate, subacute, glabrous, nearly or quite entire.

Type, *Tate 408*, collected on the summit of Mt. Roraima, alt. 8650 ft., 24 Nov. 1927, and deposited in the herbarium of the New York Botanical Garden. Other material in the Kew herbarium is *Im Thurn* without number, *Quelch and McConnell 94* (in part) and *646* (in part).

**Calolisianthus Imthurnianus** (Oliver) Gleason, new comb. (*Lisianthus Imthurnianus* Oliver) Summit of Mount Roraima: *no. 442*.

**Symbolanthus Quelchii** (N. E. Brown) Gleason, new comb. (*Lisianthus Quelchii* N. E. Brown) Summit of Mount Roraima: *no. 397*.

CHELONANTHUS sp., the same as *Ule 8448* from the Rio Branco, alt. 3000–4000 ft., which has been identified as *C. Schomburgkii* (Griseb.) Gilg. It does not match the type of that species, *Schomburgk 298*, which has the broad connate leaves of *C. chelonoides*. The specimen consists of a fruiting plant 6 dm. high, and an apparently depauperate flowering plant 4 dm. high, bearing a corolla only 25 mm. long. The flowers of the Ule plant are 42 mm. long. It probably represents an undescribed species, but no name has been assigned because of the lack of suitable flowers for examination. Lower slopes of Mount Roraima: *no. 179*.

MANDEVILLA sp. Slopes of Mount Roraima at Arabupu, alt. 4200 feet: *no.* 228. This plant is the same as *Ule 8450* in the Kew herbarium, which has been named *M. Schomburgkii* K. Schum. This name has apparently not been published. Our material is insufficient to justify describing it as the type of a new species.

HYDROLEA MULTIFLORA Mart. In marshes at Frechal and Limao, extreme northern Brazil: *no. 14, 76*. This obscure species has been very poorly represented in herbaria. The new material permits me to offer the following emended description of its floral characters.

Sepals 5, separate, oblong-lanceolate, 3.2 mm. long, enlarging during anthesis to 5.5 mm., acute, 1-nerved, obscurely reticulate, glabrous (no. 14) or thinly glandular-puberulent (no. 76); corolla campanulate, the tube stout, expanding from 0.6 to 1.2 mm. in length, its 5 lobes equal, enlarging from 1.9 to 3.5 mm. long; stamens 5, equal, inserted between the corolla-lobes; filaments 0.2 mm. wide at base, eventually 2.6 mm. long; anthers dithecous, versatile, the two halves almost separate, curled, longitudinally dehiscent; ovary stoutly ellipsoid, 2 mm. long, the axial placentae thick and protruding, with numerous ovules; styles 2, 2 mm. long, slender, diverging at base, inarched at the summit; stigmas capitate; fruit a many-seeded capsule.

LANTANA sp. Riverside at Arabupu, slopes of Mount Roraima, alt. 4200 feet: *no. 195*. This is the same as *Jenman 6339* from the Rupununi savannas, erroneously labeled *L. mixta* L. in the Kew herbarium. It may well be an undescribed species, but no name has been assigned to it because of the confusion affecting many species of the genus.

CACONAPEA AURICULATA (Rob.) Pennell. Close to *Herpestis gracilis* Benth., from Brazil, which seems to differ in outer sepals 'oblong,' rather than triangular-acuminate, and plant wholly glabrous (not even puberulent), but which may show real contrasts when we can see authentic specimens of it. In a marsh at Limao, extreme northern Brazil: *no. 120*.—F. W. PENNELL.

**Caconapea verticillata** Pennell & Gleason, n. sp. Stem erect or ascending from a creeping base, 5–8 cm. long, 4-angled, below glabrous, above with sessile yellowish glands; leaves apparently in whorls of 6, actually opposite, each cleft nearly or quite to the base into 3 linear, distally dentate, glandular-dotted segments 3–5 mm. long; pedicels 1 or 2 in an axil, scarcely evident; bractlets subulate, 1 mm. long; sepals glabrous and glandular-dotted, the outermost 3 mm. long, elliptic-lanceolate, two median narrower and one-sided, these three green, obtuse or mucronulate, minutely ciliate, two innermost lanceolate-attenuate, widely hyaline margined, 2–2.5 mm. long; corolla 2.5 mm. long, glabrous throughout, probably white, the posterior lobes united for part of their length, the three anterior lobes spreading; filaments glabrous, the posterior pair shorter; anthers uniform; style glabrous; stigmas 2, spreading; capsule 2–2.2 mm. long, ellipsoid-oblong, glabrous, dehiscing nearly loculicidally; placentae narrow, thin, median to the septum; seeds 0.2–0.3 mm. long, cylindric, brown, not evidently reticulate.

Type, *Tate 72*, collected on mud where water is receding at Limao, extreme northern Brazil south of Mount Roraima, 21 Sep. 1927, and deposited in the herbarium of the New York Botanical Garden; isotype at the Academy of Natural Sciences of Philadelphia. It differs from other species by its cleft leaves, and, at least from those of Columbia, also by loss of reticulations on the seed-coat.—F. W. PENNELL.

**Stomoisia spicata** (Sylvén) Gleason,[4] new comb. (*Utricularia spicata* Sylvén). This species was described in 1908 from material collected by Malme in 1903 at Cuyabá, Matto Grosso, and does not seem to have been reported from any other locality. It is very distinct from all other American species of *Stomoisia* by the manner in which its calyx-lobes become accrescent after flowering, enclosing and much exceeding the capsule like large valves, their edges appressed to each other so that the effect to the eye is like that of a winged fruit. Tate's locality is also in Brazil, but more than a thousand miles north of Cuyabá, and at first sight such a distance might seem unreasonable. But the intervening country is little explored and is mostly covered with a dense tropical forest, a country poorly adapted to the growth of this savanna-loving plant. In water at Frechal, extreme northern Brazil: *no. 19*.—J. H. B.

**Calpidisca calycifida** (Benj.) Gleason, new comb. (*Utricularia calycifida* Benj.) Philipp Swamp, Mount Roraima, alt. 5100–5200 feet: *no. 342*.

**Calpidisca Humboldtii** (Schomb.) Gleason, new comb. (*Utricularia Humboldtii* Schomb.) Philipp Swamp, Mount Roraima, alt. 5100–5200. *no. 316*. When Robert Schomburgk first visited the upper slopes of Roraima, in 1838, he found there a beautiful dark blue flower, called by the natives 'Roraima iperua,' the 'Flower of Roraima.' This he described in 1840 under the above name. It has the largest and most conspicuous flowers of any Lentibulariaceous plant, and well deserves the praise that has been showered upon it. Schomburgk found it in only one place, but further exploration has revealed a somewhat wider distribution. Two marked forms are known, which

[4] The segregation of the polymorphic genus *Utricularia* is due primarily to the careful studies of Dr. Barnhart, who identified this and the following five other species of the family. At his own request, the six new combinations made here have been credited as printed.

may eventually prove to be distinct species; the dark-flowered terrestrial form, apparently confined to the higher slopes of Roraima, above 1500 meters, and a paler-flowered form growing in water in the leaf-bases of the bromeliad *Brocchinia cordylinoides* on Kaieteur Savanna, at about 300 meters, where it was discovered by Im Thurn in 1884. No morphological differences between the two forms, however, have yet been noted. The *Brocchinia* grows in both places, also showing two strikingly different forms, and it is said that the dark-flowered Roraima *Calpidisca* is sometimes, although rarely, found associated with the *Brocchinia* leaf-bases. Tate did not approach Roraima over the usual route, by Kaieteur, and his specimens are of the Roraima form.—J. H. B.

**Calpidisca roraimensis** Gleason, new comb. (*Utricularia roraimensis* N. E. Brown) Summit of Mount Roraima: *no. 386.*

**Orchyllium Campbellianum** (Oliver) Gleason, new comb. (*Utricularia Campbelliana* Oliver) Rondon Camp, Mount Roraima, alt. 6900 feet: *no. 514a.* Although not named and described until 1886, the description was based upon plants collected on the upper slopes of Mount Roraima by Schomburgk many years earlier. The collections by Im Thurn in 1884, by McConnell and Quelch in 1894, and by Tate in 1927 were all from the upper slopes. This and *O. Quelchii* appear clearly distinct, but they are very closely related; both have crimson corollas, a rare character in the genus *Orchyllium.*—J. H. B.

**Orchyllium Quelchii** Gleason, new comb. (*Utricularia Quelchii* N. E. Brown) Summit of Mount Roraima: *no. 375.*

**Cephaelis Tatei** Standley, sp. nov. Omnino glabra, ramulis gracilibus, obtuse tetragonis, internodiis 2–4.5 cm. longis; stipulae 4–5 mm. longae, persistentes, erectae, fere ad basin bifidae, lobis ovalibus, apice rotundatis; folia opposita, petiolo gracili, 8–13 mm. longo; lamina oblonga vel anguste oblonga, 11–17 m. longa, 2.5–5 cm. lata, longe sensimque acuminata, basi acuta, subcoriacea, supra viridis, nervis manifestis sed non elevatis, subtus pallidior, olivacea, costa gracili, elevata, nervis lateralibus utroque latere c. 13, gracillimis, prominulis, angulo lato adscendentibus, arcuatis, marginem fere attingentibus, nervulis manifestis, reticulatis; inflorescentia terminalis, 5–6.5 cm. longe pedunculata, capitato-umbellata, capitibus 4–5, densis, paucifloris, pedunculis 1.5–2.5 cm. longis; bracteae exteriores late ovatae vel ellipticae, acutae vel ob-

tusae, 1.5–2 cm. longae, 1–1.5 cm. latae, interioribus brevioribus; flores sessiles; calyx persistens, truncatus, 0.8 mm. longus; fructus ovali-globosus, 6–7 mm. longus, obtuse costatus.

British Guiana: Arabupu, slopes of Mount Roraima, alt. 1260 m., Jan. 1, 1928, *G.H.H. Tate 262* (Herb. N. Y. Gard., type).

Although several apparently related species of *Cephaelis* have been described from Roraima, none of them agrees in all its respects with the present plant.—P. C. STANDLEY.

**Viburnum roraimense** Killip & Smith, n. sp. Tree, glabrous throughout, the branches subangular; petioles 8–15 mm. long; leaf-blades ovate, 8–12 cm. long, caudate-acuminate (tip 1–2 cm. long), rounded or subacute at base, subentire, conspicuously reticulate-veined, the nerves about 6 to a side, arcuate-ascending; peduncles 4–8 cm. long, usually slightly curved; bracts narrowly elliptic-spatulate, 3–4 cm. long, 5 mm. wide, conspicuously reticulate-veined, deciduous; corymbs 7- or 8-rayed, 5–8 cm. wide, 2- or 3-times branched, bracteolate, the bractlets about 1 mm. long, soon deciduous; calyx-tube 1–2 mm. long, glabrous, very sparsely glandular-punctate, the lobes ovate, rounded, 0.6–0.7 mm. long, faintly ciliate; ovary furrowed; fruit (immature) ovoid, greenish.

Type, *Tate 500*, collected 4 Dec. 1927 on Mount Roraima, British Guiana, alt. 2100 m., and deposited in the herbarium of the New York Botanical Garden. The species is also represented by Jenman's *220*, collected in the same locality.

BACCHARIS sp. Savanna at Arabupu, slopes of Mount Roraima, alt. 4200 feet: *no. 273*. This is the same as *Appun 1165* from the same locality.

### 2. ADDITIONS TO THE KNOWN FLORA OF RORAIMA

In the only enumeration of the montane flora of Roraima, Brown listed 239 species of seed-plants from elevations exceeding 5000 feet. No summary has been made of the number of species collected by Ule. The Tate collection includes apparently 157 species, of which 134 have been fully identified, and from them 50 species of seed-plants may now be added to the list, bringing the total to 289 species, and it would doubtless be well over 300 if the results of the Ule explorations were also incorporated.

There is no distinct vegetation-line on the mountain at 5000 feet, this level being chosen arbitrarily by Brown, probably

because it is higher than any other mountains in the Guianas, except those of the immediate neighborhood of Roraima. Considering the general luxuriance of tropical vegetation, we may well be surprised at the small number of species known, which will probably be doubled after thorough botanical exploration. The mountain needs especially exploration at other seasons of the year; Brown noted that all visits to the higher altitudes had been made late in the year, and both Ule and Tate followed the usual precedent.

Among the 50 species to be added, a part includes species of wider distribution, frequently extending far from the Roraima region. These may have been known already from Roraima, but only from the lower levels, and are now reported from the upper levels for the first time. The second group comprises endemic species only, some of which have been previously known from the lower levels and others of which are here described for the first time. Not every specimen listed was collected first by Tate; several in both groups were detected by Ule and have been described from his material.

Group 1. Non-endemics

PANICUM CARANNASENSE Mez
PANICUM CYANESCENS Nees
PASPALUM CONTRACTUM Pilger
THRASYA PETROSA (Trin.) Chase
TRACHYPOGON PLUMOSUS (H. & B.) Nees
CAREX PURDIEI Boott
XYRIS JUPICAI L. C. Rich.
ERIOCAULON HUMBOLDTII Kunth
ELLEANTHUS AUREUS Reichb. f.
EPIDENDRUM REPENS Cogn.
HABENARIA DECIPIENS Lindl.
MALAXIS HASTILABIA (Reichb. f.) Kuntze
PLEUROTHALLIS VAGINATA Schlecht.
PEPEROMIA BASELLAEFOLIA HBK.
WEINMANNIA VENEZUELENSIS Killip & Smith
POLYGALA ADENOPHORA DC.
POLYGALA FENDLERI Chod.
CLUSIA ROSEA Jacq.
PTEROLEPIS GLOMERATA (Rottb.) Miq.
RAPANEA GUYANENSIS Aubl.
BLEPHARODON STEUDELIANUS (Miq.) Pulle
NEPHRADENIA ACEROSA Dcne.
BUCHNERA ROSEA HBK.
CALPIDISCA CALYCIFIDA (Benj.) Gleason
SETISCAPELLA SUBULATA (L.) Barnh.
STOMOISIA JUNCEA (Vahl) Barnh.
EMMEORHIZA UMBELLATA (Spr.) K. Schum.
ACHYROCLINE SATUREIOIDES (Lam.) DC.
EUPATORIUM INULAEFOLIUM HBK.
EUPATORIUM LAEVIGATUM Lam.
MIKANIA MICRANTHA HBK.

Group 2. Endemics

XYRIS DECUSSATA Gleason
XYRIS RORAIMAE Malme
XYRIS SUBMONTANA Gleason
SYNGONANTHUS BIFORMIS (Brown) Gleason
SYNGONANTHUS GLANDULOSUS Gleason
DROSERA MONTANA RORAIMAE (Kl.) Diels
WEINMANNIA LAXIRAMEA Killip & Smith
POECILANDRA RETUSA Tul.
HYPERICUM RORAIMENSE Gleason
MAHUREA EXSTIPULATA Benth.
PASSIFLORA SCLEROPHYLLA Harms
GRAFFENRIEDA OBLIQUA Triana
TIBOUCHINA PSEUDOMOLLIS Gleason
BEJARIA TATEI Gleason
BLEPHARODON ULEI Schlecht.
PALICOUREA OBTUSATA Krause
SIPANEA GALIOIDES Wernham
VIBURNUM RORAIMENSE Killip & Smith
CALEA TERNIFOLIA Oliver

This brings the total number of endemic species to 139, or slightly less than half. This proportion will be further decreased by more extensive exploration of the upper slopes of the mountain. Endemism is most pronounced on the summit. Excluding the Ule collections, 76 species of seed-plants are now known from this high plateau, and of these no fewer than 68, or nearly 90 per cent, are endemic.

# A morphological study of some Phalarideae, with special reference to classification

WILLIAM E. RIECKEN

(WITH PLATES 20, 21 AND FOUR TEXT FIGURES)

Classifications of the Gramineae have been made at various times, some for purely economic reasons, others solely with the aim of describing them. The different classifications invariably make exceptions for certain genera or groups of genera because the characters selected as a basis for classification do not clearly differentiate them. Thus, one finds certain genera having some characteristics which would place them with one group while other characteristics obviously place them with another group.

Though considerable work has been done on some grasses, especially those of economic importance such as our cereals, yet there are certain species or genera on which little detailed morphological work has been done with the view of aiding in the determination of their proper position in the classification. Some interesting relationships in the structure and development of the floral parts of certain grasses of doubtful position are revealed from a morphological study of stained microtome sections.

The family Gramineae, including all true grasses, is in modern classifications divided into two great subfamilies: (1) the Poatae, exemplified by *Poa*, in which the spikelets are one- to many-flowered with reduced florets, if any, above the perfect ones, the rachilla articulating above the glumes, and the spikelets more or less laterally compressed; and (2) the Panicatae, with *Panicum* as an example, in which the spikelets have one perfect terminal floret with a sterile or staminate floret below, the rachilla articulating below the more or less dorsally compressed spikelets. The subfamilies are further subdivided into tribes each of which embraces a number of genera.

The basis of distinction between the two great subfamilies is especially unsatisfactory because of the use of such characters as the articulation of the rachilla above or below the glumes, the persistence of the glumes, and dorsal or lateral compression of the spikelets, which are, from the standpoint of natural relationship probably not very fundamental. Due to this artificial

characterization of these groups, genera have frequently been changed from one tribe to another or grouped together into the same tribe when there was no relation between them to warrant such grouping. There are yet some tribes which do not fit well in the subfamily in which they are classified, indicating that there is doubt as to their real affinities. This doubt arises from the fact that part of the characteristics indicate that they belong to one group while others would place them with the other group. Such conditions can be remedied only by a better knowledge and use of morphological characters.

One of the groups of genera which presents such uncertain classification is the tribe Phalarideae. In the spikelets of the grasses of this tribe are found usually three florets, the uppermost one being perfect, the lower either staminate as in *Torresia*, or rudimentary as in *Phalaris* and *Anthoxanthum*. These rudimentary florets have been overlooked or ignored in most descriptions and the spikelet described as having empty lemmas. In practically all modern classifications the Phalarideae are placed in the subfamily Poatae, in spite of the fact that the spikelets of the grasses of this subfamily have the perfect floret below and the upper lemmas empty or subtending either staminate or rudimentary florets. Yet it has seemed proper to place this tribe in this subfamily because its genera appear to be more closely related to the species of this group from their other structural characters. They have the articulation of the rachilla above the glumes and the laterally compressed spikelets which are characters used to distinguish the tribes of this subfamily.

It is the purpose of this paper to present such evidence from a morphological study of several genera of this tribe as will help in determining its proper position.

## HISTORICAL

The earlier classifications attempted before 1860 were very loose, in that they did not distinguish the truly one-flowered spikelets from those having but one functional flower, and since they were worked out before the doctrine of evolution had had a substantial influence upon classification, no attempt was made to show evolutionary relationships as is found in the classifications made since then. An example of such an attempt

is found in the classification of Sinclair (1869), in which he uses as the basis for his division the number of florets apparent in each spikelet, the number of stamens and styles in each floret and the number of valves (lemmas and paleas) of the 'corolla'. He found it necessary to make nine distinct groups and also numerous exceptions for certain genera.

More recent classifications take into consideration the evolutionary development of the plants and attempt to arrange the groups in the order of their relationship to one another. In most cases we find the Gramineae divided into thirteen tribes which are grouped into two large subfamilies.

Bentham and Hooker (1883), Hackel (1889, 1890), and Lamson-Scribner (1897) divide the Gramineae into two subfamilies, the Panicaceae and the Poaceae, on the basis of the articulation of the rachilla above or below the glumes, the prolongation of the rachilla beyond the florets, and the number of florets in the spikelet. Bentham and Hooker and Lamson-Scribner further emphasize the arrangement of the fertile and sterile florets, placing those tribes which have the uppermost florets perfect in the Panicaceae. The former make exceptions in the Panicaceae for *Isachne*, *Beckmannia*, and a few species of *Setaria*, and in Poaceae the genera *Crypsis*, *Cornucopiae*, and *Alopecurus* of the tribe Phalarideae and the genera *Fingerhuthia*, *Polypogon*, *Coleanthus* and *Nardus* are exceptions, while Lamson-Scribner places the Phalarideae in the Poaceae, but explains that the perfect flower is uppermost with four empty glumes below. Hackel uses the length of the internodes as an additional differential character and states specifically that of the four glumes in the Phalarideae the two inner ones rarely act as flowering glumes for staminate flowers. This does not provide for *Torresia*, which the writer finds regularly having the two staminate florets below. Hackel includes in the Phalarideae the genera *Ehrharta*, *Microlaena*, *Tetrarrhena*, *Phalaris*, *Anthoxanthum* and *Hierochloë*.

Baillon (1894) stresses the same characteristics as those just discussed, but instead of forming two large subfamilies, he divides the Gramineae into eleven tribes, one of which is Phalarideae, and in this tribe includes the same genera as given by Hackel.

Lamb (1912) develops in detail the scheme suggested by Bessey that the Bambuseae are the most primitive of the Gra-

mineae, and that from this tribe may be derived three main phylogenetic lines based on the position of the larger flowers in the spikelet. One line, the Festucean line, contains those grasses having the larger flower at the base of the spikelet. With this group he connects the Festuceae, Agrostideae, Aveneae, Hordeae and Chlorideae. In a second, the Phalaridean line, having the larger flowers at the top, he includes the Phalarideae, Oryzeae and Paniceae. The third group, the Andropogonean line, having the larger flowers at the top and the spikelets in pairs, includes the Andropogoneae and Maydeae.

The writer considers the order of development in the spikelet to be a better indication of phylogeny than is the relative size of flowers offered by Lamb, for the *larger* flowers are not always the *older*, an example of which we find in *Torresia odorata*.

The most extensive recent work which has been done on classification of the Grasses is that of Hitchcock (1914, 1920). In his publications he divides the Gramineae into two subfamilies on the basis of the number of florets in the spikelet, the relative position of the reduced or imperfect florets, and the articulation of the rachilla above or below the glumes. He, too, finds that exception must be made in his classification for the Phalarideae, which are grouped with the Poatae, for, instead of having the reduced florets above the perfect ones, this tribe has the rudimentary florets below the perfect one.

It is obvious that the bases used in the classification of the Gramineae have not been altogether very satisfactory. It is desirable to have a basis which would include the different genera without the necessity of making exceptions.

The double aim of any system of classification is to group plants for convenience in treatment and at the same time to represent as nearly as possible their actual relationships. Modern practice attempts to arrange plants on the basis of the complexity of their floral structures, placing the more primitive first and the more highly developed last. In their evolution from a common origin, species tend to vary. Because of this tendency and because this development does not follow the same straight line in the different variations, it is possible to find that some plants which have become most highly developed in one group may exhibit evidences of being far in advance

of the most primitive of the next higher group (see Hitchcock, 1920, p.2). It thus becomes difficult to arrange them on any basis and at the same time show their genetic relationships. A morphological examination of the species may aid in determining these relationships and in giving us a truer basis for comparing them.

## MATERIAL AND METHOD

For this study there were available four species: *Phalaris canariensis* L., *Phalaris arundinacea* L., *Anthoxanthum odoratum* L., and *Torresia odorata* (L.) Hitchc. of the tribe Phalarideae. The material for *Phalaris canariensis* and *Anthoxanthum odoratum* was given to me by Dr. Weatherwax, who brought seeds of both species from Georgia. *Phalaris arundinacea* is found growing wild in clumps near Bloomington, Indiana, and *Torresia odorata* was obtained from clumps growing wild near Winamac, Indiana.

*Phalaris canariensis* was grown in the greenhouse from the seed, and successive generations were grown from the seeds produced by the greenhouse plants. The plants grew and thrived under these conditions, producing an abundance of viable seeds which germinated well after a period of rest. Seeds planted in flats in the greenhouse in the fall grew well during the winter and in April flowered and bore fruit. An attempt to grow plants the following June from these seeds which matured in April resulted in failure, but some of the same packet of seeds germinated and grew readily when planted the following September in the greenhouse.

Clumps of *Phalaris arundinacea* which were observed showed that it propagates very easily by underground stems. An unsuccessful attempt was made to grow it in the greenhouse from seed. The panicles were observed to bloom, and after blooming the spikelets appeared to contain well developed seeds, each appearing well filled and plump. Their failure to germinate led to an examination of some of the spikelets, which when opened were found to contain but a small dried up pistil instead of a well developed seed; the lemma and palea enclosing this withered pistil gave the spikelet the appearance of having a well developed seed. The same condition was found when spikelets of three other seasons were examined, yet it was possible to

trace the development of the embryo sac as far as the megaspore stage. Further study needs to be made to determine whether viable seeds are formed. Clumps of plants with the underground stems that have been dug up and grown in the greenhouse during the winter and then carried outside during the summer have not formed any inflorescences but have sent out new shoots at many of the upper as well as the lower nodes. These nodes with shoots form roots which take hold of the soil and make separate plants.

All of the material was fixed in chromo-acetic acid or formol-acetic-alcohol, dehydrated slowly, and embedded in paraffin, from which the sections ten microns thick were cut. All sections were stained with the triple stain, anilin safranin, gentian violet, and orange G.

The contracted panicles of *Phalaris canariensis* are dense, ovoid, 1–1.5 inches long. The laterally compressed spikelets contain one perfect terminal floret and two lower lemmas, all of which are wholly enclosed by the two boat-shaped glumes (figs. 1, 2). In longitudinal sections of the spikelet are found evidences of the rudimentary floret in the axil of each of the lower lemmas, which are often referred to as the second and third glumes. Thus this species has a spikelet which is fundamentally three-flowered with the two lower florets rudimentary (figs. 3, 4).

In the development of the panicle, the uppermost spikelets are the first to mature. The significant thing, however, is the order of the development of the parts of the spikelets, which is found to be from the lower to the uppermost, that is, the glumes, and the first, second, and third lemmas are developed in the order named, though in very close succession (fig. 5). No evidence could be found of the prolongation of the rachilla beyond the uppermost floret. A very noticeable structure of the first and second lemmas is the very much thickened basal region which ends uppermost in a very thin membranous tip. The outer or dorsal layer of cells of these thickened bases have thin walls, and are very much larger than the inner denser cells (fig. 6). The rachilla disarticulates just above the glumes. At the point of disarticulation, the rachilla is very small, and it seems possible that the layer of large cells of the sterile lemmas by hygroscopic action may function in the ejection of the

caryopsis. The caryopses have been observed disconnected and lodged between the upper ends of the two glumes.

The panicle of *Phalaris arundinacea* is open during anthesis, after which it is closed, forming a long cylindrical contracted panicle. The lanceolate spikelets are included by two wingless glumes. What has been said with reference to the structure of *P. canariensis* applies likewise to *P. arundinacea* (fig. 7). The two lower lemmas probably show more of a tendency to be reduced to bristles above the much thickened basal portions (fig. 8). These basal regions also show the single layer of much enlarged cells on the dorsal side. The lower members of the spikelet are developed earlier than the upper as in the preceding species.

In *Anthoxanthum odoratum* (fig. 9) the unequal glumes enclose, besides the perfect terminal floret, two hairy, bifid, dorsally awned lemmas (fig. 10). These lemmas show evidence of having an undeveloped floret in the axil of each (fig. 11). The perfect terminal floret has but two stamens, no lodicules, and usually a two-parted plumose stigma. In the development of the spikelets of this species it is found that it agrees with the two species of *Phalaris* in the order of the development of the parts, the lower members appearing earlier than the upper (fig. 11). Here again is found the layer of enlarged cells on the ventral side of the first and second lemmas.

The open panicle of *Torresia odorata* is composed of three-flowered spikelets (figs. 12, 14), with the terminal floret perfect and the two lower florets staminate or frequently empty. In the terminal and in the lower florets, when the latter are developed, are found three stamens. In dissecting the spikelets just before anthesis it is quite obvious that the lower florets are more advanced than the upper (fig. 13). Material for a more detailed study of sections was not available in time for this paper, but the order of development of the spikelet is very evident from the spikelets which were dissected just before anthesis, and is found to agree with the other three species described (fig. 13). Sections were not necessary in this case to ascertain whether the spikelet is more than one-flowered since the first and second lemmas show fully developed staminate flowers in their axils.

## ANOMALIES

Some anomalies were observed in some of the specimens which were dissected. In a few cases in *Phalaris canariensis* and *Torresia odorata* spikelets were found in which the two filaments of the two lateral stamens were united into one for two thirds of the distance up from the base but were distinct at the top with an anther on each (figs. 15, 16). In *Anthoxanthum odoratum* and in *Torresia odorata* (fig. 17) instances were noted in which the stigmas were three-parted.

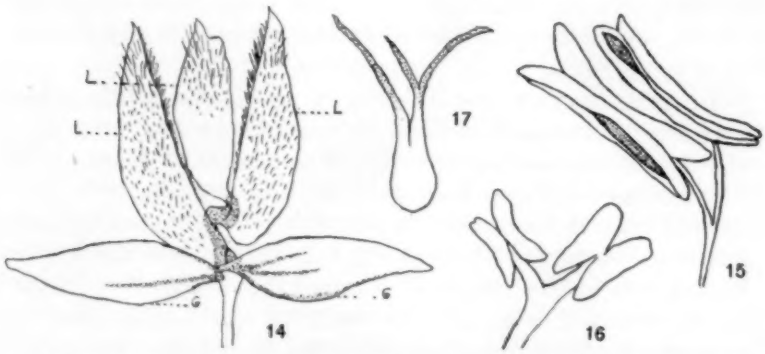


Fig. 14. *Torresia odorata*. Spikelet with glumes pulled apart, showing the three enclosed florets. ×3.7. *G*, glume; *L*, lemma. Fig. 15. *T. odorata*, and fig. 16 *P. canariensis*, showing the united filaments of the lateral stamens. ×3. Fig. 17. *T. odorata*, showing the three-parted stigma. ×3.

## DISCUSSION

The three genera are closely comparable in the structure of the spikelet and in the order of the development of its members. The spikelet of *Torresia* clearly shows three flowers fully developed. The flowers in the first and second lemmas, being staminate and more advanced than the uppermost, definitely exhibit an indeterminate condition. In the first and second lemmas of *Anthoxanthum* and *Phalaris* are found evidences of florets which do not develop very far, and in each of these species it is found from sections made of early stages that the lower members of the spikelet are more advanced than the upper; therefore all of them show the same indeterminate condition.

It is found that the spikelet of *Anthoxanthum* differs from the other species in the absence of lodicules and in that the perfect, uppermost floret has but two stamens, but agrees in all other features very strikingly with the other three species here described.

A prolongation of the rachilla beyond the uppermost floret could not be observed in any of the sections made in any of these species, although Mrs. Arber (1925) reports having found a definite prolongation of the rachilla in the genus *Ehrharta* of this tribe.

The following similarities in these species are observed and may be used as a basis of comparison: (1) that each has a spikelet which is morphologically more than one-flowered, (2) that in each the order of development of the members of the spikelet is the same—the lower members developing first, and (3) that it is the uppermost spikelet in each case which is the perfect one with the incomplete or aborted florets below.

Lamb attempted to overcome the difficulties of present classifications, and his method based on what he considered the evolution of this family is a tendency in the right direction; but the basis which he selected, that of the relative position of the large and small flowers of the spikelet does not present a phylogenetic relationship. However, it is believed that a morphological study and comparison of the order of development of the spikelet does present phylogenetic relationships which can be used as a basis for classifying the Gramineae.

If, in classifying the Gramineae, we use as a basis the structure of the spikelet and the order of development of the members of the spikelet, we can say that these species, judging from the similarities enumerated above, constitute a distinct group. Upon this basis it is possible to group the Phalarideae with the Poatae without making them an exception, and it seems possible to divide all the Gramineae having more than one flower in the spikelet on this basis without the necessity of making exceptions. Such a basis has already been pointed out by Weatherwax (1923), who states that

> A sharp line of distinction may be drawn between one group of genera, in which the spikelet is indeterminate, and another in which it is determinate. In the one the lower flower is most advanced in development, and abortion is most likely to occur at the top; in the other, this order is reversed.

Though in an indeterminate inflorescence the abortion of parts is most likely to occur at the top, yet in Phalarideae the abortion has occured below the developed floret. However, the order of development still holds, for the lower members are the most advanced.

On this basis those species of Gramineae which have more than one flower in the spikelet may be divided into two groups: (1) those genera in which the spikelet is more than one-flowered and determinate; and (2) those in which the spikelet is more than one-flowered but indeterminate. The Phalarideae, then, being more than one-flowered and indeterminate, would thus be classed with the latter group.

## SUMMARY

1. The tribe Phalarideae has never consistently fitted in with the classifications which have been made of the Gramineae, due to the fact that it was judged only by characters which are external. It is here suggested that the remedy is to be looked for in the better use of the morphological characters to emphasize phylogenetic relationships.

2. Through a morphological study of the development of the spikelets it is found that the Phalarideae form a definite group, in that they have in common a spikelet with a perfect terminal flower, that they have more or less evidence of rudimentary flowers in the axils of the lower lemmas, and the spikelets all develop in the same order—the lower members being the more advanced.

3. On the basis of the order of the development of the florets in the spikelet, the Gramineae having more than one flower in the spikelet may be divided into two groups: the Panicatae with determinate inflorescence, and the Poatae with indeterminate inflorescence. With this fundamental division of the family, we can consistently place the tribe Phalarideae in the Poatae without making it an exception.

The writer wishes to express his appreciation of the criticism and suggestions of Dr. Paul Weatherwax who suggested the problem, and under whose direction this work was done in the laboratories of Indiana University.

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**Explanation of plates 20, 21**

PLATE 20

Figs. 1–6. *Phalaris canariensis.*

Fig. 1. Whole spikelet. ×7.

Fig. 2. Spikelet with glumes removed. ×7. *L*, lemma.

Fig. 3. Longitudinal section of the spikelet. ×7.

Fig. 4. Cross section of the spikelet. ×25. *L*, lemma; *G*, glume; *R*, rudimentary floret.

Fig. 5. Longitudinal section of young spikelet showing the order of development. ×25. *G*, glume; *L*, lemma; *P*, palea.

Fig. 6. Longitudinal section of empty lemma showing enlarged cells on the dorsal side. ×6.

Fig. 7. *P. arundinacea.* Longitudinal section of the spikelet. ×6.

PLATE 21

Fig. 8. *P. arundinacea.* Spikelet with glumes removed. ×6. *G*, glume; *L*, lemma; *R*, rudimentary floret; *P*, palea; *Pi*, pistil; *St*, stamen.

Figs. 9–11. *Anthoxanthum odoratum.*

Fig. 9. A spikelet. ×3 *G*, glume; *L*, lemma; *A*, awn of lemma; *Pi*, stigmas of pisil.

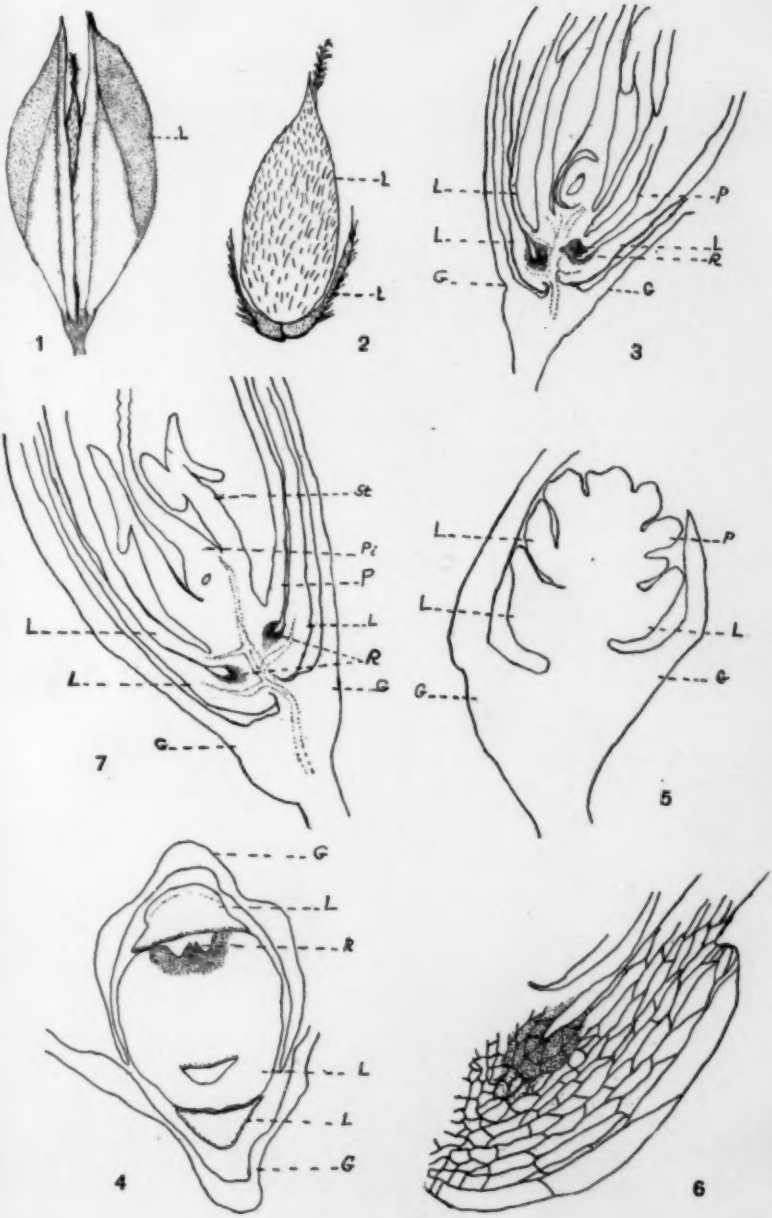
Fig. 10. Two spikelets, the upper one with glumes removed. ×3.

Fig. 11. Longitudinal section. ×3. *G*, glumes; *L*, lemma; *R*, rudimentary florets; *P*, palea; *Pi*, pistil; *St*, stamen.

Figs. 12, 13. *Torresia odorata.*

Fig. 12. A spikelet. ×3.

Fig. 13. Spikelet showing only the essential organs; lower florets more advanced. ×3.7. *St*, stamen; *Pi*, pistil; *Ra*, rachilla.

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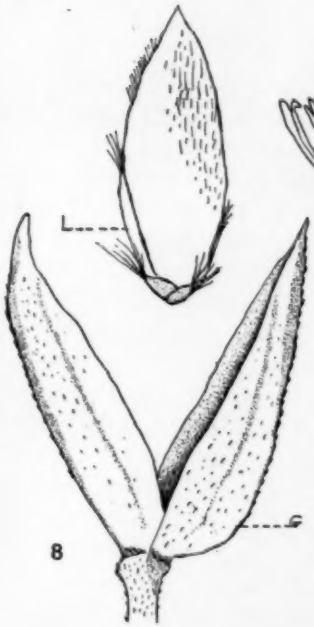


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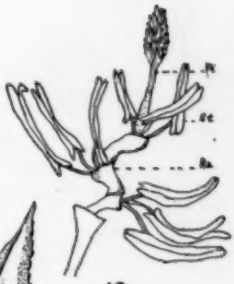


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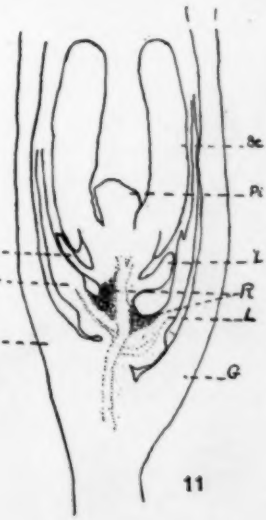


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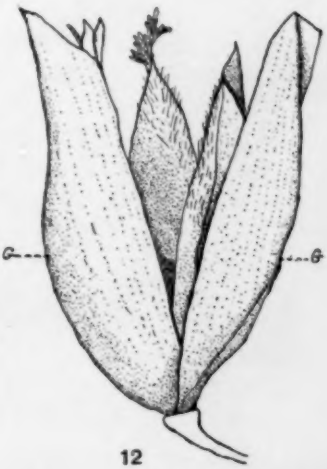


12

RIECKEN: PHALARIDEAE

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# Fresh water algae from the Green River formation of Colorado

WILMOT H. BRADLEY[1]

(WITH PLATES 22, 23)

In the writer's investigation of the origin of the group of lake beds of Colorado, Utah, and Wyoming, known as the Green River formation, a systematic study of the microfossils was made in addition to the geologic studies, in order to aid in interpreting the conditions that prevailed in the ancient lake. This lake existed for several million years during the middle part of the Eocene epoch, which is the earliest epoch of the Tertiary Period. Although the Eocene represents a rather late epoch in the earth's history, rocks formed during the middle of that epoch are probably of the order of forty million years old. The complete report on this investigation will be published by the United States Geological Survey.[2] Professor Gilbert M. Smith, of Stanford University, criticized the parts of that manuscript describing the algae and offered very helpful suggestions concerning the analogy between them and certain living forms. Later, when the writer published the descriptions and figures of a few of these fossil algae in a brief paper (Bradley, 1929) bearing on the interpretation of certain disputed structures in other oil shale deposits, Professor Smith[3] suggested that as these fossil algae might be of as much interest to botanists as to geologists it would be desirable to publish descriptions of some of them in a journal that circulates chiefly among botanists. This paper was prepared in accordance with that suggestion. The writer wishes to express here also his appreciation to Professor Smith for his thorough criticism and generous help.

## OCCURRENCE

Because these algae were fossilized in a manner different from that of most fossils, a brief consideration of their occurrence will assist to explain the preservation of such delicate and normally ephemeral organisms. The Green River formation

[1] Published by permission of the Director, U. S. Geological Survey.

[2] BRADLEY, W H. The origin and microfossils of the oil shale in the Green River formation of Colorado and Utah. U. S. Geo. Surv. Prof. Paper (in preparation).

[3] Personal communication, July, 1929.

consists chiefly of thinly laminated beds of marlstone that contain a relatively small quantity of organic matter. Associated with the marlstone beds are groups of oil shale beds which are in reality only marlstone and shale beds with an extraordinarily large proportion of organic matter. All of these beds were laid down in a large and comparatively shallow lake which for a large part of its life was essentially a fresh water body. The beds considered here, therefore, are simply compacted and lithified lacustrine oozes and the organic matter they contain was derived predominantly from minute aquatic organisms that inhabited the lake. It is in the richest beds of oil shale or in other words in those that contain the greatest proportion of organic matter that the fossil algae described here were found.

Most of the thin sections of these organic rocks were ground in the same way that ordinary rock sections are cut. Others, however, were cut in a microtome after the mineral matter had been removed and the organic matter softened in hot concentrated phenol.

Two kinds of organic matter can be clearly distinguished in the thin sections. One is entirely structureless, translucent, and lemon-yellow to reddish-brown. It makes up the groundmass of the rock and contains various quantities of finely divided mineral matter. The other kind of organic matter consists of complete or fragmentary organisms such as algae, fungi, protozoa, insects, and parts of higher plants, as spores, pollen grains, or minute pieces of tissue.

*Chroococcus?* sp. cf. *C. Westii* (W. West) Boye, P. (plate 22, fig. 1). This fossil alga seems to belong to the Chroococcaceae. All the individuals consist of a pair of broadly ovate semicells that range from 12 to 18.5 microns in diameter. The cell walls are thick and homogeneous. Sheaths are apparently absent though originally they may have been present and have merely contracted and merged with the cell wall thus making it appear somewhat thicker. The shape and size of these cells agree very well with the living *C. Westii*. The cells of *C. Westii*, without the sheaths, range from 13 to 27 microns in diameter (Geitler, 1925 p. 78, fig. 70). The reticulate system of shrinkage cracks, which are unmistakable under the microscope, lend the fossil a superficial resemblance to certain sculptured dinoflagellates.

The microflora of the Green River oil shale contains more individuals of this species than any other. In one specimen the writer calculated that there were about 5700 individuals per cubic centimeter. This calculation, though subject to large errors, is probably of the right order of magnitude.

*Crinalium?* sp. cf. *C. endophyticum* Crow (fig. 2). These strap-shaped filaments are much like those of Crow's genus *Crinalium* (Crow, 1927). They are duplex, slightly twisted, and without apparent transverse septa. Moreover, some of them are sharply bent in the middle, though none are really U-shaped. They differ from *C. endophyticum* in that they are nearly 7 microns broad, whereas the filaments of the living species are 3 to 4 microns in diameter. Like other fossil algae of this micro-flora no sheath is discernible and it is impossible to tell if there ever was one. Filaments like these are common in the oil shale and all are much broken by shrinkage cracks.

*Hapalosiphon* sp. cf. *H. confervaceus* Borzi (fig. 3). This alga is remarkably suggestive of certain living species of *Hapalosiphon*, yet it does not agree exactly with any of them. It comes closest to *H. confervaceus* Borzi, but differs in being slightly smaller and in not having its filaments coated with small grains of calcium carbonate as described by Geitler (1925, p. 201). The trichomes of *H. confervaceus* range from 15 to 22 microns in diameter, whereas those of the fossil range from 11 to 13 microns. Moreover, no sheath is discernible in the fossil alga and it is impossible to tell if it ever had one. The fossil also resembles *H. aureus* W. and G. S. West, but is more richly branched and the branches are about the same size as the principal filament rather than smaller. *H. flexuosus* Borzi has all the characters of the fossil, but is considerably smaller. Its trichomes average 6-8 microns in diameter.

*Phacus* sp., cf. *P. caudata* Hübner (plate 23, fig. 4). This pyriform cell is remarkably like certain species of the euglenoid genus *Phacus*. The short, straight caudal spine, the asymmetry of the forward end, and the dimensions are very close to *P. caudata* Hübner, which is 22.5 microns wide and 45 microns long (Lemmermann, 1913). The fossil is about 25 microns wide and 46 microns long. However, no longitudinal striae and no longitudinal fold are discernible, though these characters may have been obscured during compaction and lithification of the

ooze in which the organism was embedded. The fossil is also very nearly like *Lepocinclis teres* (Schmitz) Francé, especially in the shape and length of the spine, but this living species is symmetrical. This fossil is remarkable in that it apparently represents the preservation of a naked protoplast. In commenting upon this fossil Professor Smith[4] called the writer's attention to a central light dot in just the position of the paramylon-grain of *Phacus*. Examination in polarized light shows that this dot is due to the presence of a minute mineral grain which only by chance happens to occupy the position of the paramylon-grain.

*Tetraedron* sp. cf. *T. regulare* var. *torsum* (Turner) Brunnthaler (fig. 5). This alga shows a striking resemblance to the living *Tetraedron regulare* var. *torsum*. It is excellently preserved and shows no shrinkage cracks. It is brownish-orange and although clear and translucent it is somewhat darker than the groundmass. The alga appears to be perfectly homogeneous and all differentiation between the cell wall and contents has disappeared.

*Coelastrum?* sp. cf. *C. verrucosum* Reinsch (or *Pediastrum?* sp.) (fig. 6). This group of cells which the late Charles A. Davis (1916) regarded either as a *Pediastrum* or a member of a closely related genus may be a *Coelastrum*. It is somewhat similar to *C. verrucosum* Reinsch. According to this interpretation this group of eight cells represents a flattened and partly fragmented coenobium whose cells were more or less rounded and lobed. The individual cells of *C. verrucosum* (Reinsch 1877) are about 9.7 microns in diameter, whereas those of the fossil measure about 10 microns across. But the irregular lobes on the cells of the fossil are apparently more rounded and larger in proportion to the size of the cell than the irregular wart-like prominences on the cells of *C. verrucosum*. Nevertheless, the number of the cells, their size, and general aspect are nearly enough like *C. verrucosum* to warrant the suggestion that the fossil may be a species of *Coelastrum* comparable to *C. verrucosum* Reinsch.

*Microspora* sp. cf. *M. pachyderma* (Wille) Lagerheim (fig. 7). This alga, which is represented in the microflora of the Green River formation by ı single fragment, is very close to *M.*

[4] Personal communication, Jan., 1928.

*pachyderma* in filament structure, cell shape, and dimensions. The filament of the fossil is about 16.5 microns in diameter and the cells average 13.5 microns in diameter and 20 microns long. The cells of *M. pachyderma* are 9 to 12 microns in diameter and 1 to 2 times as long as wide. (Heering, 1914, p. 152).

The color of this fossil is unusual. It is pale lemon-yellow and almost transparent, whereas most of the algae in the oil shale are reddish-yellow, reddish-orange or dark reddish-brown. The color is very close to that of the pollen grains and waxy spore exines found in the oil shale.

*Stigeoclonium?* sp. cf. *S. lubricum* (Dillwyn) Kützing (fig. 8). It is not at all certain that this fragment of a branching alga belongs here. Too little of the character of the cell contents is known to be sure in the first place whether it is a member of the Chlorophyceae or Cyanophyceae. However, it is placed here provisionallly because its manner of branching and the size and shape of the cells are so suggestive of *S. lubricum*. The cells are quadrate or cask-shaped and range in diameter from about 7 to nearly 10 microns. Hazen (1902, p. 196) gives the diameter of the branchlets of *S. lubricum* as 6 to 7 microns and the diameter of the principal filaments as 14 to 16.5 microns. The fossil, which is unusually large compared with other specimens of the microflora, also resembles the blue-green alga *Capsosira* Kützing (see Geitler, 1925, p. 171), but shows no indication of the heterocysts characteristic of this genus, and in its branching and general aspect is more like *Stigeoclonium*.

## MANNER OF PRESERVATION

The structureless organic matter in which these and other algae are embedded was derived from the partial decomposition of minute aquatic organisms that dwelt in the ancient lake. It seems probable that planktonic algae furnished the greater part of the original gelatinous ooze but probably other aquatic organisms like protozoa, bacteria, and various insect larvae also contributed. When the decomposition of these organisms reached a certain stage, bacterial activity evidently ceased or was greatly retarded and the resulting gelatinous ooze remained essentially stable and apparently somewhat antiseptic. Comparable deposits of richly organic ooze are known in certain existing lakes. This gelatinous ooze acted as a protecting

medium against the activity of putrefactive bacteria and so preserved delicate organisms like algae and fungi that became accidentally entombed in it. Presumably the cells of these algae were partially impregnated with the ooze in somewhat the same manner that amber penetrated the tissues of its plant inclusions. Thus these algae were supported, or rather, suspended in a gelatinous matrix until the whole mass had become hardened into rock. It appears that many of the algae in the Green River oil shale contained more moisture than the matrix, for they contracted more, and so are broken by numerous shrinkage cracks. (See plate 22, fig. 3).

U. S. GEOLOGICAL SURVEY
WASHINGTON, D. C.

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**Explanation of plates 22, 23**

The photomicrographs from which figures 1–3 of plate 22 and figures 6 and 8 of plate 23 were taken were made under the direction of the late Charles A. Davis. The other photomicrographs were taken by the writer.

PLATE 22

Fig 1. *Chroococcus* sp. cf. *C. Westii* (W. West) Boye, P. The alga shows a reticulating system of shrinkage cracks. ×430.

Fig. 2. *Crinalium?* sp. cf. *C. endophyticum* Crow. The transverse shrinkage cracks in these algae give an erroneous impression of transverse septa. ×185.

Fig. 3. *Hapalosiphon* sp. cf. H. *confervaceus* Borzi. The reticulating system of shrinkage cracks in this alga resemble that in the *Chroococcus*. ×375.

PLATE 23

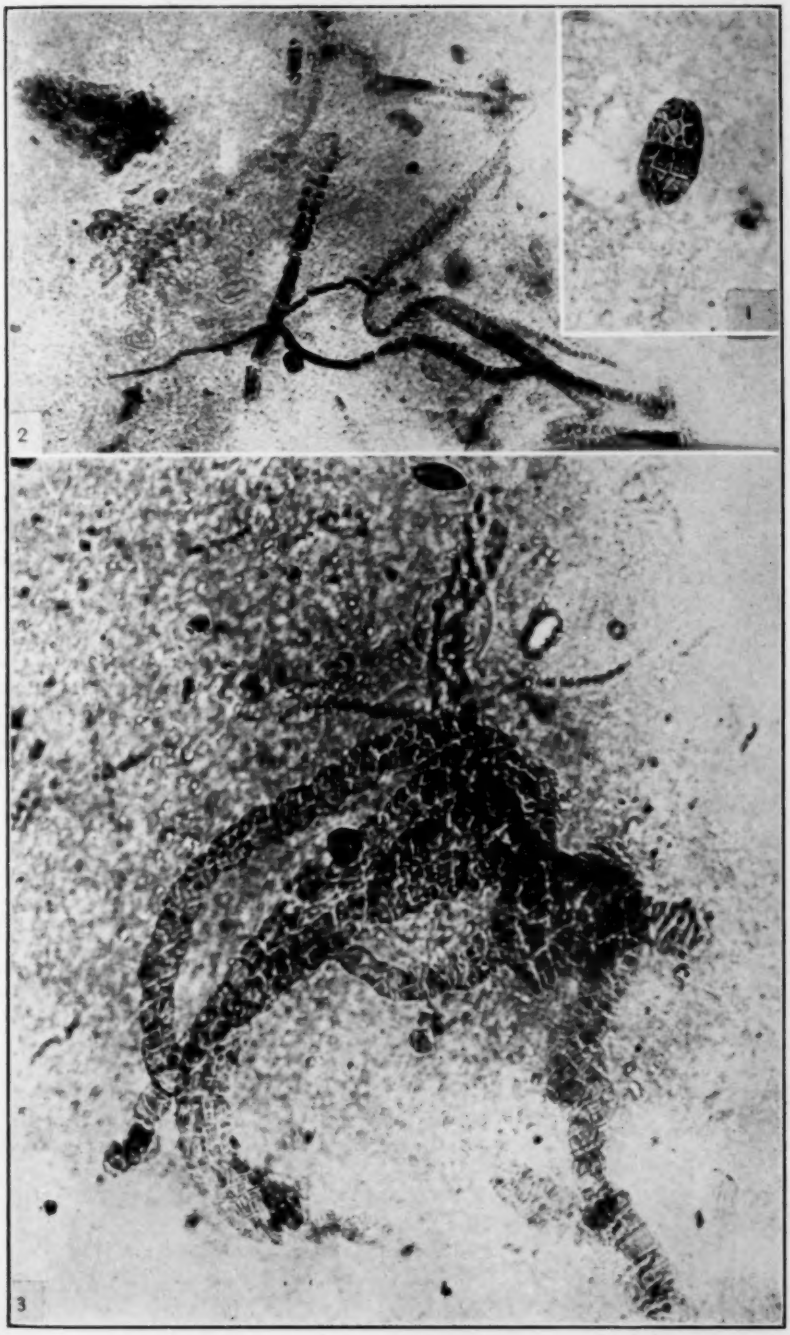
Fig. 4. *Phacus* sp. cf. *P. caudata* Hüber. The transverse cracks are due to shrinkage. The light dots and angular areas are mineral grains which, together with the fossil, are embedded in the light gray structureless organic matrix of the oil shale. ×410.

Fig. 5. *Tetraedron* sp. cf. *T. regulare* var. *torsum* (Turner) Brunnthaler. This alga shows no shrinkage cracks and is embedded in an oil shale whose mineral grains are somewhat coarser than the others. ×200.

Fig. 6. *Coelastrum?* sp. cf. *C. verrucosum* Reinsch (or *Pediastrum?* sp.). These cells show no shrinkage but were probably somewhat distorted during compaction of the sediment. ×740.

Fig. 7 *Microspora* sp. cf. *M. pachyderma* (Wille) Lagerheim. This photomicrograph was taken from a microtome section of the oil shale from which all the mineral grains have been removed. It shows more clearly than the other that the volume of structureless organic matter in these oil shale beds greatly exceeds the mineral matter. ×250.

Fig. 8. *Stigeoclonium?* sp. cf. *S. lubricum* (Dillwyn) Kützing. The shrinkage cracks in this alga are small and consequently the transverse walls are more plainly discernible. ×410.




BRADLEY: GREEN RIVER FORMATION ALGAE

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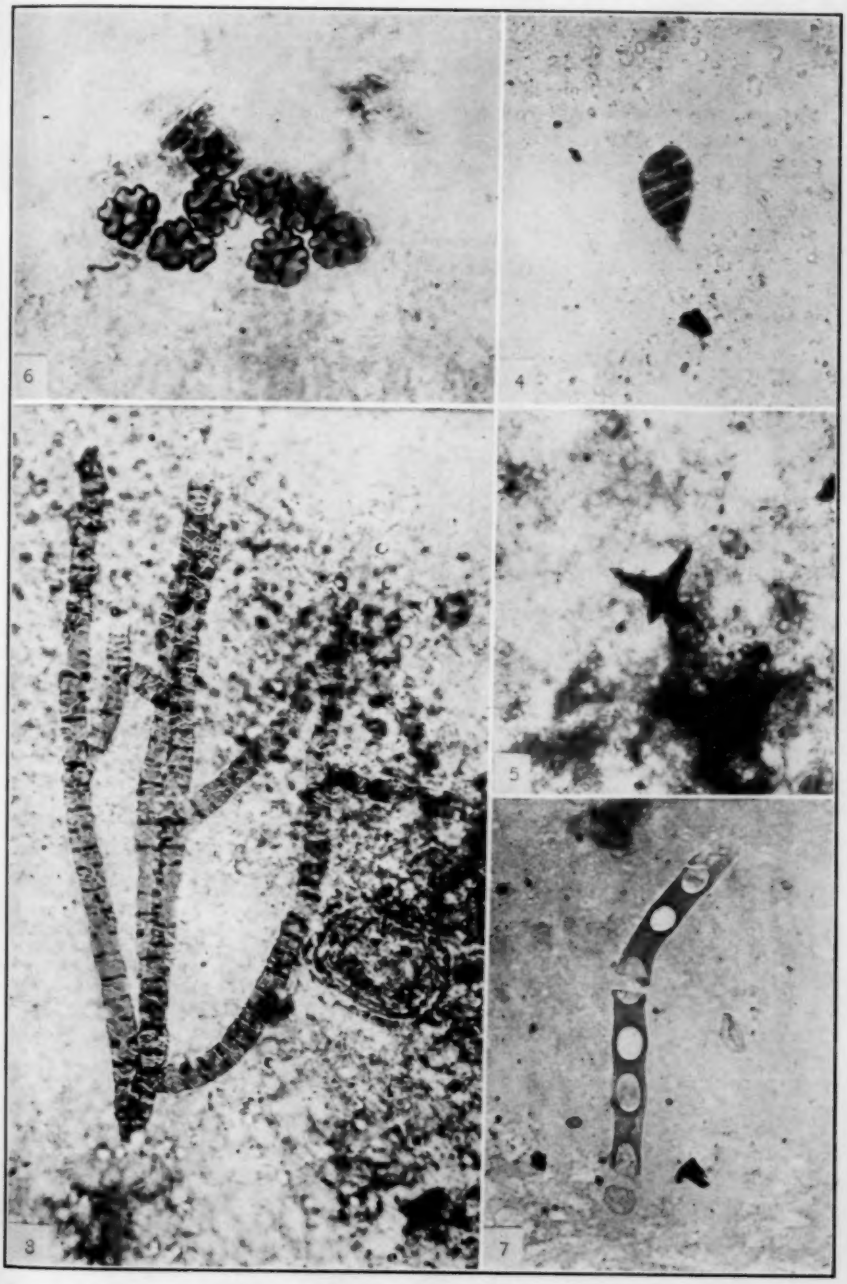


BRADLEY: GREEN RIVER FORMATION ALGAE

## INDEX TO AMERICAN BOTANICAL LITERATURE
### 1924–1929

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

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